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EVERETT, MASS.

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REPORT NO. 6-8-50G-1

MONTHLY PROGRESS REPORT

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EB-180E-1

ENGINEERING PROGRAM FOR THE
DEVELOPMENT OF A LIGHTWEIGHT
ANTI-TANK ROCKET

FOR THE PERIOD

MONTH OF JUNE 1958

CONTRACT NO. RD-142

~~ORDNANCE PROJECT NO.~~

~~DEPT. OF ARMY PROJECT NO.~~

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HESSE - EASTERN DIVISION

FLIGHTEX FABRICS, INC.

PROGRESS REPORT #10

ENGINEERING PROGRAM FOR THE DEVELOPMENT OF A LIGHTWEIGHT ANTI-TANK ROCKET

JUNE 1958

CONTRACT NO. RD-142

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FLIGHTEX FABRICS, INC.
EVERETT, MASSACHUSETTS

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WORK DONE DURING THE MONTH OF JUNE 1958

REPORTING PERIOD 4 JUNE 1958 TO 4 JULY 1958

SYSTEM EVALUATION PROGRAM

Manufacture of the final motors and head assemblies has started. Some difficulties with primer ignition have been experienced. Tests on Evaluation No. 2 fuze have been completed, and Model No. 3 has been designed. A redesign of the launcher has resulted in a saving in weight and cost per system as well as making it possible to reduce the size of the package considerably.

The accuracy of the round at both ambient and low temperature appears to be satisfactory. Functioning time of the fuze has been consistent (.001 seconds), and additional crush-up data have been obtained.

MOTOR DEVELOPMENT PROGRAM

The igniter combination which produced the best results in previous tests was used in conjunction with a better and more positively acting adhesive for holding the propellant to the studs. (Paraplex as manufactured by the Rohm and Haas Company and commonly used for this purpose.) The results are shown on the following tabulation:

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IGNITION AND ACCURACY TEST - 6/16/58

Paraplex adhesive for propellant sticks, 25 cal. cartridges, 3 grams of black powder, 1/4" taken off propellant length. Tested at ambient temperature. Weight of rounds 1,550 grams ± 7 gram. See Photograph No. 86 for hits on 10' X 10' target -25°F.

Rd. No.	Vel. F/S	Target Hit	Burning Time	Out of Launcher Burning	Comments
186					Primer failed to ignite black powder
187	300	Low Center	.032	1 Foot	
188	332	Center		None	Mech. trouble; 15 minutes out of conditioner
189		High			20 minutes out of conditioner; went off when disassembling
190					Primer fails to ignite black powder
191	294	Under	.031	6 Inches	Long ignition delay
192					Primer did not initiate black powder
193	312	High left	.032	6 Inches	
194	312	Center	.031	6 Inches	
195	312	Center	.027	6 Inches	

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The primers did not reliably ignite the black powder, and the test results are therefore inconclusive. It was therefore decided to conduct a program of ignition tests in order to insure reliable initiation of the black powder at all temperatures. It was assumed that if the black powder is ignited at the low temperature no trouble would be experienced igniting it at the high temperature.

The following combinations were therefore tried:

1. 3 grams of black powder with a double layer of polyethylene to contain the black powder charge.

2. A perforated disk behind the polyethylene.

3. 4 grams of black powder filling the 25 cal. shell and reaching to the same level as the igniter used so far.

4. As No. 2, only using a large hole connecting the cartridge with the black powder cup.

5. 3 grams of black powder with four layers of polyethylene.

The ignition tests were conducted by placing a fully assembled practice round with a prototype igniter assembly in the test launcher. The round contained no propellant, but the igniter was loaded with black powder. Five rounds of each combination were fired with the following results:

Combination No. 1

Round Nos. 1, 4 and 5 failed to ignite the black powder. Round Nos. 2 and 3 ignited the black powder.

Combination No. 2

All rounds functioned with the exception of No. 2 which

failed to ignite the black powder. On Round No. 10 an excessive amount of flash was observed.

Combination No. 3

All rounds ignited the black powder.

Combination No. 4

Round No. 2 did not ignite the black powder. On Round No. 4 very slow burning of the black powder was observed. Round No. 3 - a hissing sound could be heard approximately 2 seconds before the black powder ignited.

Combination No. 5

Round Nos. 1, 2 and 4 and 5 ignited the black powder. Round No. 3 failed to ignite it.

Evaluation of results of this test shows that only Combination No. 3 ignited the black powder reliably. Since the test was run at the low temperature, no further difficulties were expected at the high temperature. It was therefore decided to conduct a flight test with Combination No. 4. Since some danger existed that 4 grams of black powder would give an excessive amount of ignition pressure, it was decided that only 3 grams of black powder would be used for the flight test and the retaining ring which secures the polyethylene in the powder cup was correspondingly moved back into the cup to contain a charge of only 3 grams of black powder. In addition, two 1/4" vent holes were drilled through the igniter body directly in front of the 25 calibre cartridge. The openings to the atmosphere caused by these holes were covered over with a double layer of scotch tape.

The purpose of this was to provide a pressure relief. Round Nos. 216 to 222 were prepared in this way.

Another igniter test without propellant was then conducted with 5 rounds having the above igniter configuration. The result of this test was 100 per cent initiation of the black powder. Some time delay was observed in Round No. 2. However, it appeared to be small. The decision was therefore made to conduct a flight test.

The results of this test are shown on the following page. After the first round (No. 216) which failed to ignite the propellant charge, a change in the igniter assembly was made as follows:

The original configuration of 3 grams of black powder in the igniter cup was retained. A wire screen was placed behind the black powder. The pressure relief holes were retained.

(See Ignition and Accuracy Test - 6/27/58 on following page.)

Evaluation of Ignition and Accuracy Test 6/27/58

It appears that unreliable ignition at the low temperature is still being obtained with 3 grams of black powder. The accuracy and velocity of the round when properly ignited appear to be satisfactory. It was therefore decided to use 4 grams of black powder without vent holes filling the powder cup to the previous level and to conduct another flight test at the low temperature.

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IGNITION AND ACCURACY TEST - 6/27/58

Two 1/4" diameter vents in igniter next to cartridge. Three grams of black powder loaded into cartridge with resulting shifting back of the black powder charge. Tested at ambient temperature.

Round No. 216 - Black powder failed to ignite propellant.

Igniter configuration changed 1/4" vent holes retained screen used behind black powder charge. Three grams of black powder in original configuration. Ambient temperature.

Rd. No.	Velocity F/S	Target Hit	Burning Time	Out of Launcher Burning	Comments
217	335	Center Left	.021	6"	
218	320	"	.032 Intermittant	1 Foot	
219	142	No	Two Partly Burned Sticks (Without Cracks) Left in Motor		
220	315	Center	Intermittant	No	
221	315	Center	.022 Intermittant	1 Foot	
222	325	Center	"	3"	

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(See Ignition and Accuracy Test - 7/2/58 on following page.)

Evaluation of Ignition and Accuracy Test 7/2/58

It appears that ignition of the propellant charge has been obtained with this last combination. However, the distance between the 25 calibre cartridge and the bulk of the black powder change is causing a considerable time delay which will have to be eliminated. It is planned to conduct a test as soon as possible placing the 25 calibre cartridge as near to the powder cup as possible and lengthening the firing pin in order to retain the same relationship between the primer and the end of the firing pin and the same spring pressure of the firing pin.

A motor failure occurred on Round No. 26. This is probably accounted for by the fact that E. M. No. 2 motors are below the required strength and that this particular motor had been used for the second time.

The following observations can be made about all motor tests conducted through June:

1. A spectacular difference in motor performance has been achieved by the use of the paraplex adhesive.

2. Time-pressure curves will have to be obtained with the new adhesive to cross-check with previous calculations in order to enable us to make minor changes in propellant size and/or throat size to obtain the desired pressure level and properly maintained burning within less than 20 milliseconds at the low temperature. The propellant used in all tests throughout June is steel, but reduced in length by 1/4 of an inch. Static tests will show whether this reduction should be retained or not.

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IGNITION AND ACCURACY TEST - 7/2/58

Igniter configuration changed 1/4" vent holes eliminated

4 grams of black powder filling cartridge and powder cavity.

Rd. No.	Velocity	Target Hit	Burning Time	Out of Launcher Burning	Comments
223	308	Center Low	Intermittent double burning. Ignition delay	7 Feet	Reignites out of launcher
224	335	High Right	Double burning	6 Feet	Round out of conditioner 10 minutes. Re-conditioned for 2 hours.
225	310	Center Low	Double burning Resumes burning out of launcher at 6 ft. for 2 ft. Change in velocity from 290 to 310 F/S.		
226					Motor Failure
227	335	Center High	Same as No. 224.		

The results of testing during June have been sufficient to warrant placing the subcontract for the motors with the Harvey Aluminum Incorporated, 19200 South Western Avenue, Torrance, California. Since a certain amount of time will have to be spent in tooling up, minor changes in the motor configurations can still be incorporated if necessary.

Bull compare densities that Co obtained w/ previous Hesse-Eastern loading 1.71 avg. +.1.6

WARHEAD DEVELOPMENT PROGRAM

Drawings for the final warhead were completed and the order placed with the Eastern Tool & Mfg. Company to make a final quantity of 250 warheads. The heads loaded by Mr. W. Cox at Ordill, Illinois, were tested on 12 June, and the tabulation of the test results is included in the following page. The results are consistent with results obtained in previous tests. It is felt that the improvements in average penetration is attributable to the greater quality of the head bodies and not to the method of loading. As shown under the fuze section of this report, crush-up tests have been conducted and further confirmed the fact that the fuze functioning time can be expected to be 1,000ths of a second and the crush-up in the vicinity of 3 5/8 of an inch. This should provide the correct stand-off in dynamically fired rounds when using the final ogive which is being made at the Eastern Tool Company. In addition to this, the tooling is being made in such a way that the length of the ogive can be changed in order to make minor adjustments in stand-off. It is expected that the heads will be complete by the end of July or early August so that static and dynamic penetration tests can be conducted in the middle of August.

This is not conclusive because to date no drawn ogives have been tested - The ogives used in these tests were sawed & not reproducible

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RESULTS OF PENETRATION

TEST: 12 June 1958

DOUBLE ANGLE LINERS LOADED AT ORDILL

STANDOFF = 3 inches

Head No.	Concentricity Body	Concentricity Cone to Body	Density	Penetration
1	.008	.005	1.7	11 1/4"
2	.010	.004	1.7	13 3/4"
3	.012	.004	1.7	10 3/4"
4	.005	.004	1.7	10"
5	.006	.004	1.7	14 1/8"
6	.005	.007	1.71	13 3/4"
7	.006	.005	1.70	14 1/2"
8	.009	.004	1.71	8 3/4"
9	.009	.005	1.71	12"
10	.018	.008	1.70	10 1/2"

Greatest Penetration 14 1/2"

Average 11.9" in Mild Steel = 9.5" armor.

Greatest Variation

on the basis of these 10 shots, we have accepted & frozen the head design

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FUZE DEVELOPMENT PROGRAM

Two fuze functioning tests were conducted during the month. The new safety pin design with a camming angle on the fuze body and a corresponding angle on the safety pin in combination with the 6 ball design of the fuze was used in 9 rounds fired on 13 June. Tabulation of the test results is as follows:

TABULATION OF RESULT OF FUZE FUNCTIONING TEST - 6/13/58

DOUBLE BALL DESIGN WITH LEAD CUSHIONS; AMBIENT TEMPERATURE

Rd. No.	Safety Pins	Rd. Vel.	Crush-Up	Func. Time in Sec.	Comments
196	Design 2				Safety did not release round safe
197	"	332	3.7	.001	
198	"	335	3.6	.001	
199	"	327	3.6	.001	Safety pins did not release
201	"	335	3.6	.001	
202	"	337			Safety pin did not release
203	"				"
204	No safety pins	360	4"	.001	
205	"	345			Dud

Evaluation of Results

It appeared by examining Round Nos. 196, 199, 202 and 203 that a sharp transition from the camming angle to the cylindrical section of both the fuze housing and the safety pin caused the safety pins to jam.

also, no functioning

The rounds mentioned did not release the safety mechanism and remained safe. This shows that, with the safety pin in position, a very high degree of safety is obtained, since these rounds were subjected to both the acceleration upon launching and the deceleration when impacting the target. The functioning time of all fuzes which functioned was 1,000ths of a second and the crush-up can be seen on the tabulation. Round No. 205 did not arm, and a bouncing condition (see previous reports) appears to have been present in this round.

After examining the fuzes, a change was made in the safety mechanism introducing generous radii both at the end of the cammed groove in the fuze housing and at the end of the taper in the safety pin. This was done in order to eliminate the cocking condition encountered in the test. A second fuze test was conducted on 24 June using this new safety pin design. This design is called Pin Design No. 3. A tabulation of the test results is shown on the following page.

Evaluation of Fuze Tests 6/24/58

Since no fins were available for all rounds fired during this test, the attitude of the round was very nearly vertical, and no crush-up information is therefore available. It has to be stated that the target for both tests was a steel plate 40 feet from the launcher. The attitude of the round is shown on the tabulation. Ninety degrees means a vertical attitude, i.e., an attitude where the longitudinal axis of the round is parallel to the target. Round No. 219 was used during the flight test on 27 June. Since this round had incomplete burning of the propellant sticks,

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TABULATION FUZE FUNCTIONING TEST 6/24/58

SAFETY PIN DESIGN No. 3

FUZES AS USED 6/13/58

No fins were used on motors resulting in very poor round attitude.

No crush-up information is available.

Rd. No.	Velocity	Function Yes	Function No	Functioning Time	Attitude or Round
206	334	X		.001	60° - 70°
207	286	X		.001	"
208	334	X		.00075	"
209	334	X		.001	"
210	334		X		90°
211	308	X		.00125	60° - 70°
212	345	X		.00125	"
213	334	X		.001	"
214	338	X		.001	"
215	334	X		.001	"
		FUZE USED DURING TEST 6/27/58			
219	142	X		Graze	

its velocity was extremely low, and it grazed the ground at 60 yards from the launcher. The fuze set back and armed. However, it did not function on impact with the ground. It was dropped from a height of 2 feet from the ground, whereupon it initiated the detonator.

Evaluation of Test Results

Functioning time of the fuze appears to be satisfactory and consistent. The problem of bouncing has been greatly reduced (as planned) by the addition of the safety mechanism. However, the problem of making the fuze sufficiently graze sensitive still remains. Variations in the properties of the material used to prevent bouncing (lead) and the insufficient graze sensitivity of the fuze have lead to the decision to change the fuze design to a new design which will lock the triggering sleeve and inertia element of the fuze together when set back occurs. This lock will only be released when the fuze is armed. Engineering calculations and layouts for this new fuze have been completed, and it is expected that detailing will be completed in July and that a prototype will be available early in August. The basic design of the fuze remains unchanged. The interlock is merely an addition which will remove any possibility of unreliable functioning. A different way of turning the rotor and an increase in the amount of rotation will improve detonator safety and increase the arming distance.

LAUNCHER DEVELOPMENT PROGRAM

The sights of the launcher have been redesigned in order to

decrease the size of the package into which the launcher will fit. This change is shown on Photograph Nos. 87, 88 and 89. The trigger handle has also been redesigned and a new trigger handle is shown on Photograph Nos. 90, 91 and 92. The new cross-piece which was shown on Drawing No. D-8349 has been detailed and aluminum cross-pieces have been used throughout the testing conducted during June. In addition to this, these cross-pieces have been used in the static ignition tests. No mechanical difficulties have been encountered, but two small changes will still have to be incorporated in the design:

1. The brass sleeve used to guide the firing pin will have to be cemented in the igniter and the hole for the cross-piece will have to be drilled on assembly with the igniter instead of aligning the previously milled slot with a hole in the cross-piece. This will have to be done in order to eliminate any possibility of misalignment during assembly and mechanical jamming. The changes in the igniter have been discussed in the motor section. It is planned to run a series of recoil tests during July to recheck the safety and operation of the launcher and in order to get data on thrust and recoil. These tests are conducted by suspending the weapon system on two pendulums and firing the round by means of electrical ignition. A backward motion of the launcher can be observed on the Fastax film, and time versus motion can thus be plotted. It is expected that launcher drawings will be finalized during July, and final orders for launcher components placed in early August.

Evaluated vs. costs expended for the month

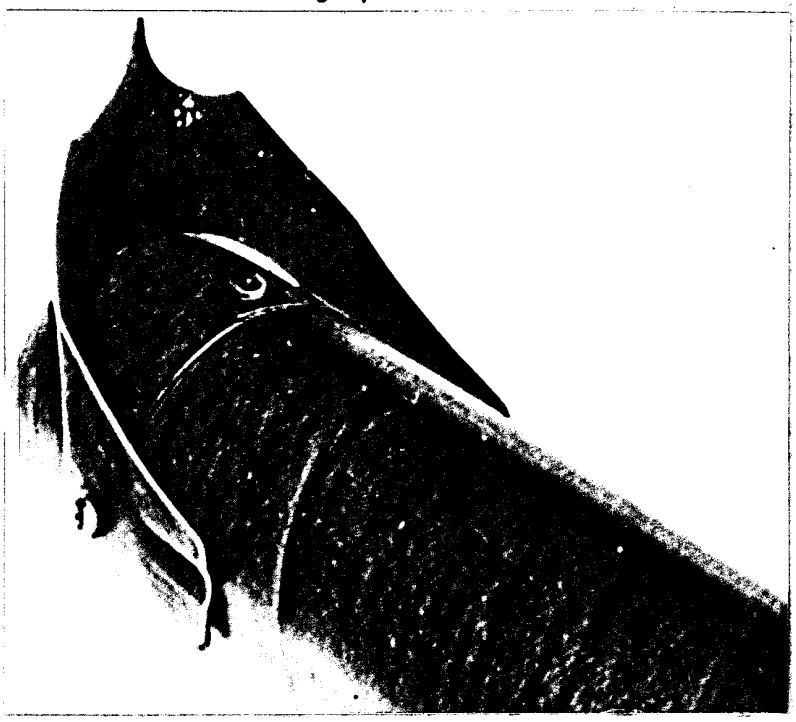
Project Engineer

#29,396.32

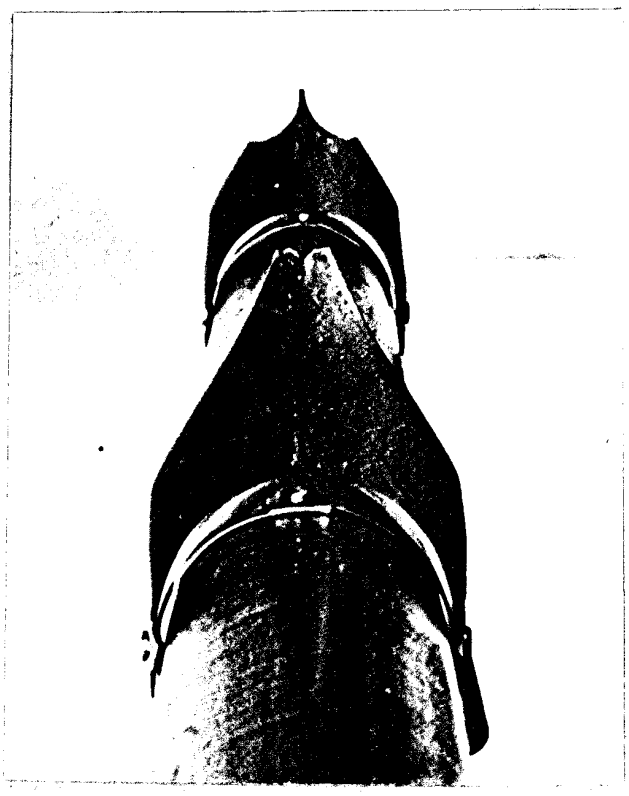
General Manager

PHOTOGRAPHS

Photograph No. 86



Photograph No. 87



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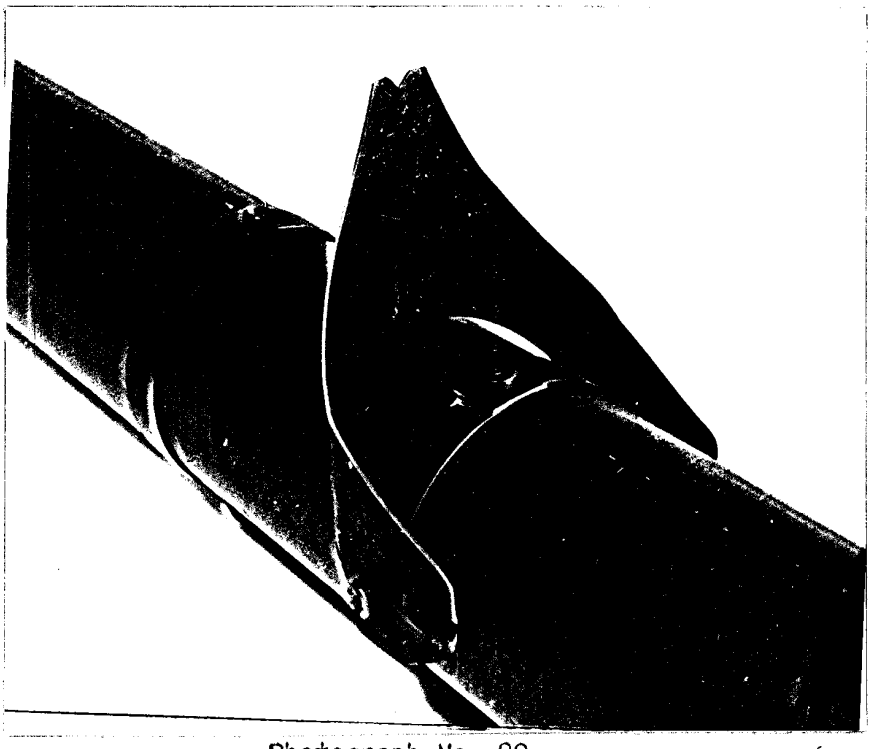

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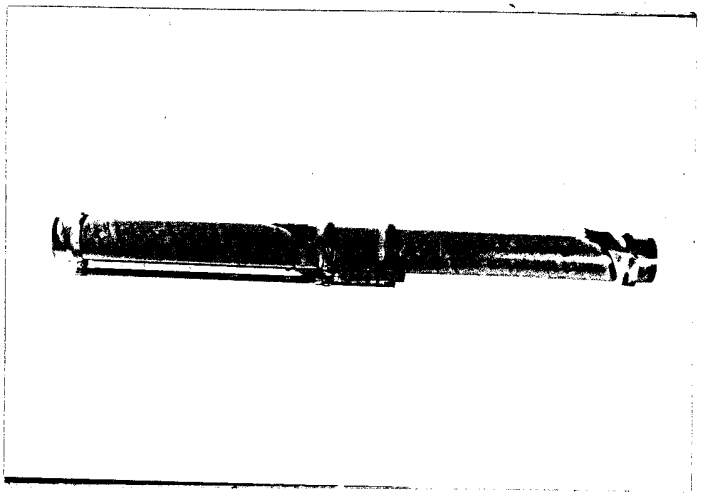

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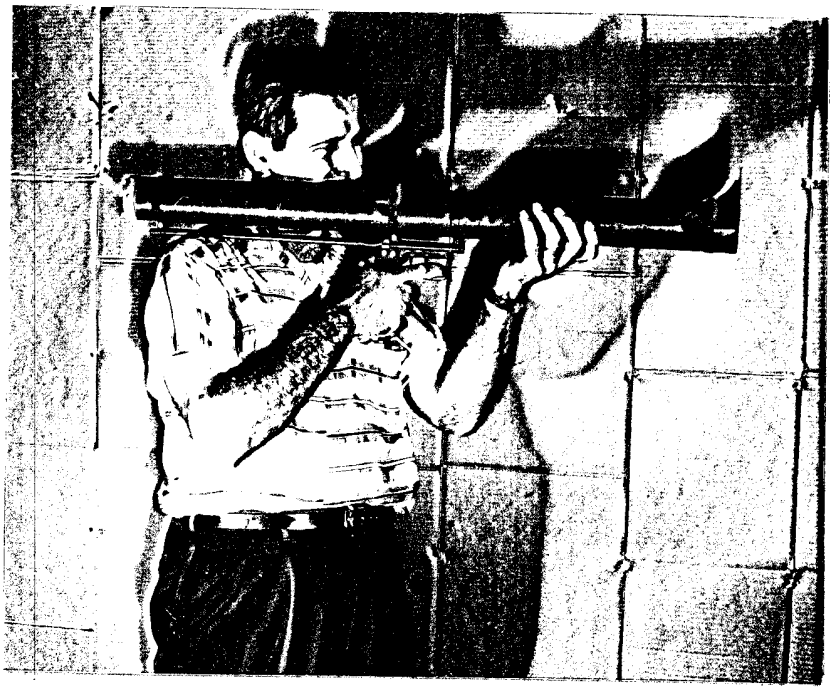

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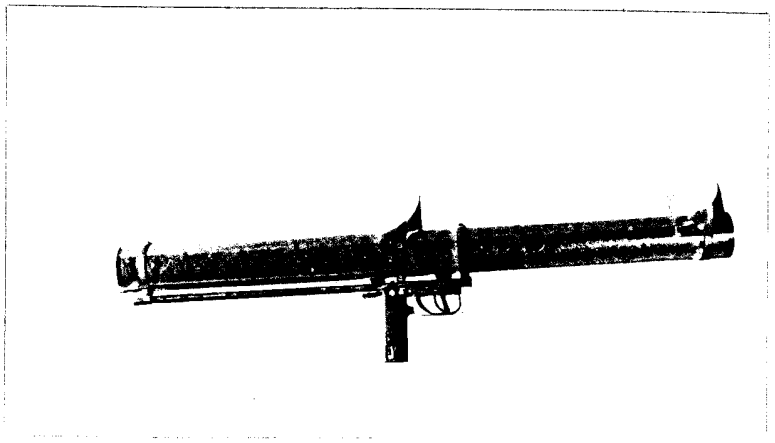

Photograph No. 92